Some Philosophical Aspects of Particle Physics

1.) Introduction — why should philosophers of science study particle physics?

(a) Relevance of studying a "core" branch of Science

(b) Testing ground for theories of how science develops

(c) Grounding for reductionist programme

(d) Speculations on the ultimate nature of physical reality.

2.) Interthery relations — Heuristic strategies

Theories to be considered

(1) Relativistic quantum field theory ✓

(2) Feynman-Dyson diagram techniques ✓

(3) Renormalization theory ✓

(4) Analytic S-matrix theory ✓

(5) Axiomatic Field theory — Haag's theorem
Haag-Kastler C* algebra ✓
formulation.

(6) Chew's Bootstrap – analyticity of the spectral function ✓

(7) current algebra ✓

(8) Unitary symmetries SU(3), SU(6) etc ✓

(9) Parton models as explanation of scaling
   (a) Bjorken & Paschos
   (b) Drell, Levy and Yan.
   (c) Landshoff & Polkinghorne?

(10) Colored quarks and charmed quarks ✓
(quark statistics, suppression ~~charmness~~ strangeness-changing neutral currents, ψ- particles)

(11) Dual resonance models
   (a) Veneziano ✓
   (b) Kobd - Nambu - Nielsen. ?
   ✓(c) String models — Nambu
   Nielsen & Olesen
   (d) MIT Bag model Kogut & Susskind.

(12) Gauge fields

(a) Yang - Mills

(b) Sakurai

(c) Salam - Weinberg → neutral currents ✓

(d) t'Hooft ← (Wheeler, Hawking, Penrose) renormalizability ✓

(e) Politzer, Gross - Asymptotic freedom

↓

Broken scaling ?

(13) Renormalization Group methods

(a) Gell-Mann, Low

(b) Wilson

(c) ⟶ Gross, Wilczek

(14) Miller theory of inclusive reactions (Feynman scaling) ✓

(15) Spontaneous symmetry breaking Goldstone's theorem and its evasion (Higgs-Kibble)

(16) Regge theory ✓

~~3~~ 1) Strategies

1) straight forward mathematical development of existing theories:

ex: 12 (c), (d) 2(e), 3 ? 14, 15.

2.) Modification of existing theory:

ex: ~~4 (a)~~,

3.) analogical extension:

ex: $SU(2) \to SU(3) \to SU(4)$ —

i.e. 8 & 10 12 (a), (2).

4.) Reformulation followed by "stretching"

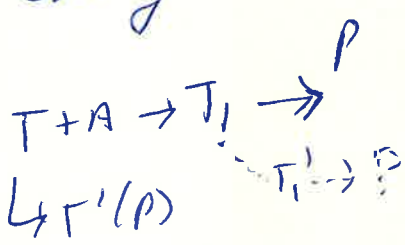
ex: 1, 11 (c), 16

5.) Close Computation gap.

ex 2.

6.) Feedback feature of some model or approximation of old theory as an excuse for the new theory

Ex 4, 7,



7) ~~Axiomatization~~ Attempts to constrain theories

ex 5, 6.

Symmetries constrain dynamics
or dynamics constrain symmetries.

8.) Making an Ansatz: Consistency problem?

ex 11(a)?, 9(b)?, 9(c)?

9.) Make a Model. by simplifying assumptions
Analogue models. or by making approximation ex 9(a), 11(a)

3) Appraisal of Theories

A Value of predictions (Experiments per theory)

Ed (1) Ω^-

(2) Ram separation

(3) Lamb shift + electron anomalies

(4) antiproton

(5) neutrino

↓

Importance of quantum production

↓ Bayesian models for methodologies & appraisal

B Heavy from experiment

↳ adhoc mechanisms

4) <u>How Science Progresses</u>

Application of views of

(1) <u>Kuhn.</u> paradigm shift
irrational band wagon
effects.

(2) <u>Popper</u> Refutation of theories

(3) <u>Lakatos</u> tenacity of hard-cores
positive heuristic
Degeneration of a research
programme.

5.) <u>Ultimate Nature of reality</u>

(1.) open ended reductionism

(2.) Chew's bootstrap, nuclear democracy

(3.) fundamental particles —
parton v. bootstrap

(4.) Unified field theory of Heisenberg.

(5) action-at-a-distance theories
illusion of fields? Hoyle-Narlikar etc.

(6) elementary particles, cosmology.
(a) Wheeler, Misner
(b) Mendel Sachs.

Queries 1.) How does duality assumption for S-matrices compare with class's analysis of 2nd kind ?

2.) What is status of Wall, Levy, Yan Field theory of ~~proton~~ point protons + assumptions in gen'l coloring

3.) Compatibility of unitarization and duality ?

4.) Renormalization group Wilson's ideas on field theory.

5.) Status of Haag's theorem